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# The effect of regional source of solid coconut sugar and additional concentration of activated carbon on the quality of pandanus-scented coconut sugar syrup

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## Abstract

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This research aimed to find the best regional source of raw materials for the manufacture of coconut sugar syrup and the right concentration of activated carbon during processing of the pandanus-scented coconut sugar syrup. The experiment was set up into a randomized factorial design with two factors: the first factor was the regional source within Indonesia of the solid coconut sugar (Malang, Blitar, or Trenggalek) and the second factor was the concentration of activated carbon (5%, 10%, 15%). The results of an organoleptic test of the sugar syrup showed no regional source effect, while the concentration of the activated carbon similarly had no significant effect on color, scent, and flavor. The best results were obtained with the solid coconut sugar from the Blitar region and with activated carbon at 5%. Quality measures of the pandanus-scented coconut sugar syrup from the best treatment were: total sugar of 67.88%, the water level of 29.46%, and ash level of 2.58%.

*Keywords:* activated carbon; coconut sugar syrup; reprocessing; solid coconut sugar

## Introduction

Solid coconut sugar is made through a process of thickening coconut sap. Generally, it is known as molded solid coconut sugar or shell-shaped solid sugar (Santoso, 1993). The main problem in the production of solid coconut sugar is the overall shape of this molded solid sugar. The product in this form is difficult to measure accurately and difficult to dissolve i n water (Susanto, 1992). The production cost is also high, which makes solid coconut sugar more expensive than cane granulated sugar (Pasaribu, 2004). Furthermore, small-scale industries producing molded solid coconut sugar rarely utilize sub-grade solid coconut sugar (Afrianti, 2008).

One of the alternatives to improve the form of solid coconut sugar is to alter it into sugar syrup since it can be used and consumed more easily in this form. One way to fulfill the demand for coconut sugar syrup is by implementing a reprocessing system of sub-grade solid coconut sugar and adding an absorbent material such as activated carbon to remove impurities. The results of a study conducted by Okviati (2009) showed that the higher the concentration of activated carbon used, the higher the rate of adsorbed impurities and hygienic coconut sugar syrup with a high amount of sugar can be produced. The selection of different origin areas of solid coconut sugar is used to know the quality of the raw material of different areas which are going to be processed to produce pandanus-scented coconut sugar syrup.

## Materials and Methods

**Sample Preparation**

The raw materials used are sub-grade solid coconut sugar originating from Tempusari Village Donomulyo Sub-Regency Malang Regency, Bagsri Village Nglegok Sub-Regency Blitar Regency, and Karangrejo Village Kampak Sub-Regency Trenggalek Regency, along with activated carbon and pandanus leaves.

**Experimental design**

The design of the experiment was a randomized factorial design using two factors: the first was the area of origin of the solid coconut sugar (i.e., Malang Regency, Blitar Regency, Trenggalek Regency) and the second was the concentration of activated carbon (5%, 10%, 15%).

**Activated carbon preparation**

The absorbent was prepared by sieving activated carbon (in granulated form, not in flakes/powder). The activated carbon was heated at $100^0$ C for 3 hours and cooled down in a desiccator, to widen the pores utilized, to enlarge the surface affecting the adsorption, and to decrease water level. After this heat treatment, it was weighed and then wrapped with cotton and straining cloth to prevent it from imparting its color to the coconut sugar syrup.

**The production of coconut sugar syrup**

Pandanus-scented coconut sugar syrup was produced by chopping 200 g of sub-grade solid coconut sugar originating from each region using a knife and dissolving it in 400 ml of water (200%, b/v) heated using a gas stove and stirred until their density rates reached 60% TPT. The activated carbon, wrapped in cotton and sieving cloth was added at either 5%, 10%, or 15% (b/v), while the solution was heated on the stirrer at 60° C for 30 min to manage adsorption. After the adsorption stage, the volume was measured and pandanus leaves were added to 10% (b/v). The mixture was heated again until the density rate reached 70% TPT (in accord with the "I" quality standard of syrup) for 7.5 min. The mixtures were cooled down to room temperature, 27° C and packaged in glass bottles.

**Organoleptic test**

An organoleptic test was administered by using Hedonic Scale Scoring assessing each attribute of the product, employing five experts as the panelists. The attributes assessed were color, scent, and flavor, which tend to affect consumer considerations in judging any product, especially new products. Furthermore, a Friedman test was conducted to identify if there is any difference among treatments, based on the preferences of the panelists.

**Determining the best treatments**

The process of determining the best treatments used the effectiveness index method. This method was administered by analyzing the data of the results of Hedonic Scale Scoring test and the results of the weighing of the criteria. Criteria weighing is a process used to determine the significance rate of the attributes of the products. The results of the weighing process were combined to the results of Hedonic Scale Scoring test. Consequently, the score of the products was obtained. The product scores represent the preference rates of the panelists towards the pandanus-scented coconut sugar syrup treatments.

**Chemical testing**

The following chemical tests were used to identify the quality metrics of the coconut sugar syrup quantitatively. Testing was only performed on the sample of the best alternative selected.

**Total dissolved solids**

The analysis of total dissolved solids was conducted by using a digital hand refractometer. Total dissolved solid was presented in the form of a percentage (%).

**Total sugar**

Sugar content was measured against a standard curve. The standard curve was produced as follows: pipette into the test tubes (.0/form); 0.2; 0.4; 0.6; 0.8; and 1.0 mL of standard glucose solution. Add water until the volume of each test tube reaches 1.0 mL. Rapidly add 5 mL of anthrone reactant into each test tube. Place the tubes in the water bath of 100° C for 12 minutes. Cool them down quickly by using running water. Place the test tubes onto cuvette; read the absorbance using a spectrophotometer at a 630 nm wavelength. Determining the Total Sugar: Add 1 mL of samples (of the prepared samples) into test tubes. Rapidly add 5 mL of anthrone reactant into each tube, close them and stir thoroughly. Place them in a water bath of 100° C for 12 min. and cool them down rapidly by running water. Place the test tubes onto cuvette; read the absorbance using the spectrophotometer at a 630 nm wavelength. Determine the concentration of total sugar of the samples using this following formula:

$$\text{Total sugar} = \frac{\chi \times \text{Dilution} \times 100\%}{\text{Weight of the sample (g)} \times 1{,}000}.$$

**Ash Content**

Weigh carefully washed and heat-dried porcelain cups and note their weights in grams. Weigh 1 to 2 g of samples and place them onto the porcelain cups. Cinder the materials in a furnace for 5 hours at a temperature of 600° C, then allow the temperature to return to room temperature; take out the cups and further cool them in a desiccator and weigh the cups to determine ash content (Benrachedi et al., 2007).

**Water content**

Weigh carefully washed and dried Petri. Weigh homogenized samples (~1–5 g). Dry them in an oven at 100–105° C for 3 to 5 hours based on the amount of material. Cool them down in desiccators and weigh them. The decrease in weight is the amount of water in the sample (Benrachedi et al., 2007).

**Determining the Yield**

The extent of yield is based on the percentage (v/w) of the volume of pandanus-scented coconut sugar syrup produced divided by the weight of the raw materials used (Benrachedi et al., 2007; Emam & Musa, 2011).

## Results

**The characteristic of the raw materials**

Sub-grade solid coconut sugar is usually in the form of rough solids and quite pliable; it is dark-brown in color and less-savory in flavor than high-grade coconut sugar. Based on Table 1, it can be seen that the highest amount of sugar was in the solid coconut sugar originating from Malang Regency, 86.41%, while the lowest amount of sugar found was from Blitar Regency, 86.29%. Malang Regency had the highest level of water content, 11.11%, while the lowest was from Trengaalek Regency, 9.50%. The level of ash/cinder is used as sugar purity parameter—the lower the level of ash, the higher the level of purity of sugar (Hamzah & Hasbullah, 1997; Hess et al., 2014). The lowest level of cinder/ash found in the coconut sugar was from Trenggalek Regency, 1.84%, while the highest was from Blitar Regency, 3.80% (Table 1).

The addition of 5% activated carbon resulted in a higher final volume than the addition of 10% and 15% activated carbon. The treatment yields in this experiment can be seen in Table 2. The more activated carbon added, the lower the final sugar syrup volume will become. The decrease of volume for each different percentage of activated carbon is likely caused by the number of compounds adsorbed by activated carbon, which is supported by Manoi and Lutungan (1990) who noted that activated carbon is very vigorous and it will absorb everything that maintains any kind of contacts with the carbon, either through water or air. According to Benrachedi et al. (2007) and Cosyn et al. (2011) activated carbon can remove organic wastes and dissolved stains; thus, it can be concluded that the more activated carbon added, the lower the final volume will become and thus a lower final yield produced (Table 2).

**Table 2. Panelists' mean scores towards the color of pandanus scented coconut sugar syrup**

| Regional origin | Level of active carbon (%) | Mean value of color scores |
|---|---|---|
| Malang Regency | 5 | 4 |
| | 10 | 3.4 |
| | 15 | 4 |
| Blitar Regency | 5 | 5.2 |
| | 10 | 5.4 |
| | 15 | 5 |
| Trenggalek Regency | 5 | 3.6 |
| | 10 | 4.2 |
| | 15 | 3.2 |

**Organoleptics**

***Color***

The mean score of Hedonic Scale Scoring for each treatment ranged from 3.2 to 5.4. These show that the range of preferences of the panelists was positioned on the level of "fairly enjoy the material" (3.2) to "vastly enjoy the material" (5.4). Based on the result of the Friedman test towards the color of the coconut sugar syrups, there was no difference between the treatments because of the value of the calculated X2 (5.2) < X2 statistic at $\alpha = 5\%$ (15.5). It shows that the color of the syrup produced was not affected by the regional source of solid coconut sugar and the percentage of activated carbon added; therefore, the origin areas of solid coconut

**Table 1. Chemical characteristics of subgrade solid coconut sugar**

| Regional Origin | Parameter | | |
|---|---|---|---|
| | Total of Sugar (%) | Water Content(%) | Ash Content (%) |
| Malang Regency | 86.41 | 11.11 | 2.26 |
| Blitar Regency | 86.29 | 9.79 | 3.80 |
| Trenggalek Regency | 88.52 | 9.50 | 1.84 |

sugar and the percentages of the addition of activated carbon should not affect the consumer preferences towards the color of pandanus-scented coconut sugar syrup.

***Scent***

The mean score of the panelist judgments of the scent of the pandanus-scented coconut sugar syrup ranged from 3.4 to 5.6. These show that the range of judgments of the panelist is positioned on the level of "fairly enjoy the material" (3.4) to "vastly enjoy the material" (5.6). The Friedman test towards the scent of the syrup showed no differences between treatments; the value of the calculated X2 (8.9) < X2 at α = 5% (15.5). It means that the scent of pandanus scented coconut sugar syrup appeared to be not affected by the regional source of the solid coconut sugar and the percentage of activated carbon added; thus, different origin areas and different percentages of activated carbon should not affect consumer preferences towards the scent of pandanus-scented coconut sugar syrup produced (Table 3).

**Table 3. Panelists' mean scores towards the scent of pandanus scented coconut sugar syrup**

| Regional origin | Level of active carbon (%) | Mean of scent scores |
|---|---|---|
| Malang Regency | 5 | 4.8 |
| | 10 | 4 |
| | 15 | 4.2 |
| Blitar Regency | 5 | 5.6 |
| | 10 | 4.8 |
| | 15 | 5.2 |
| Trenggalek Regency | 5 | 3.4 |
| | 10 | 4.4 |
| | 15 | 3.4 |

***Flavor***

The mean scores of the panelists' judgment of the flavor ranged from 1.8 to 5. These show that the range of judgments of the panelist is positioned on the level of "dislike the material" to "fairly enjoy the material" (5.4). The Friedman test towards the flavor of the syrup shows no differences between treatments; the calculated value of X2 (11.32) < X2 at α = 5% (15.5). It means that the flavor of the syrup was not affected by the regional source of solid coconut sugar and the percentages of activated carbon added; thus, different origin areas and different percentages of activated carbon should not affect consumer preferences towards the flavor of pandanus-scented coconut sugar syrup produced (Sudarmadji et al., 1997; Yuttitham et al., 2011) (Table 4, Table 5).

**Table 4. Panelists' mean scores towards the flavor of pandanus scented coconut sugar syrup**

| Regional Origin | Level of Active Carbon (%) | Mean of Flavor Scores |
|---|---|---|
| Malang Regency | 5 | 3.8 |
| | 10 | 4.8 |
| | 15 | 3.4 |
| Blitar Regency | 5 | 5 |
| | 10 | 4.8 |
| | 15 | 4.6 |
| Trenggalek Regency | 5 | 1.8 |
| | 10 | 4.2 |
| | 15 | 3.4 |

**Table 5. Panelists' mean scores towards the flavor of pandanus scented coconut sugar syrup**

| Regional Origin | Level of Active Carbon (%) | Mean of Flavor Scores |
|---|---|---|
| Malang Regency | 5 | 3.8 |
| | 10 | 4.8 |
| | 15 | 3.4 |
| Blitar Regency | 5 | 5 |
| | 10 | 4.8 |
| | 15 | 4.6 |
| Trenggalek Regency | 5 | 1.8 |
| | 10 | 4.2 |
| | 15 | 3.4 |

**The Selection of the Best Alternatives**

The selection of the best alternatives used the organoleptic test. This means that the product that was selected had a high effectiveness index, which combined the result of Hedonic Scale Scoring and the results of weighing of criteria (Table 6).

**Table 6. The score of products from all experiments managed towards pandanus scented coconut sugar syrup**

| Regional origin | Active carbon (%) | Product values | Order |
|---|---|---|---|
| Malang Regency | 5 | 0.6053 | 4 |
| | 10 | 0.5309 | 6 |
| | 15 | 0.4798 | 7 |
| Blitar Regency | 5 | 0.973 | **1** |
| | 10 | 0.889 | 2 |
| | 15 | 0.8482 | 3 |
| Trenggalek Regency | 5 | 0.054 | 9 |
| | 10 | 0.5907 | 5 |
| | 15 | 0.235 | 8 |

**Table 7. Chemical characteristic of pandanus scented solid coconut sugar**

| Treatment | Parameter | | |
|---|---|---|---|
| | Total Sugar (%) | Water Content (%) | Ash Content (%) |
| Blitar and active carbon 5% | 67.88 | 29.46 | 2.58 |
| SII | >65 | – | – |

**The chemical characteristics of the best pandanus-scented coconut sugar syrup**

The best coconut sugar syrup, the sample from Blitar Regency using 5% activated carbon was chemically analyzed for the amount of total sugar, water content, and ash content (Table 7).

**Total Sugar and Water Content**

The total sugar of the Blitar/5% sample was 67.88%. Based on the standard of SII, the requirement of qualified syrup is > 65%. Thus, it can be said that this sugar syrup fulfilled the adjusted standard. As seen in Table 7, the Blitar/5% sample water content was 29.46%. This result is fairly high, though there is no standard of SII for water content. Water contents play an important role (Manoi & Luntungan, 1990; Wong & Sanggari, 2014). Along with temperature, water activity is a large driver of food decay and rancidity. Food decay can be a microbiological, chemical, and enzymatic process or even a combination of those three. The occurrence of these three processes in many cases needs water to take place; thus, unbound water helps to quicken the process of food decay (Apriyantono et al., 1989; Zabed et al., 2014).

**Ash Content**

Hamzah and Hasbullah (1999) note that the level of ash can be used as an indicator of sugar purity. The ash content of the Blitar/5% sample water content was 2.58%. This level is fairly high, and likely partly due to impurities in the solid coconut sugar raw material. After undergoing a thickening process, ash percentage in sugar syrup increases. Another factor may be the addition of pandanus leaves into the solution of coconut sugar syrup. According to Rizal (1991) and Viator et al. (2015), the higher the concentration of the added elements during the heating process, the higher the rate of compounds dissolved in the syrup and the higher the rate of ash made.

## Conclusion

The result of the organoleptic testing of pandanus-scented coconut sugar syrup showed that different regional sources of solid coconut sugar and different concentrations of activated carbon (5%, 10%, and 15%) had no significant effect on the color, scent, and flavor of the syrup produced. The best alternative was the solid coconut sugar from Blitar Regency treated with 5% activated carbon; the amount of total sugar present in this sample was 67.88%, the water content 29.46%, and the ash content 2.58%.

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